REMARKS

Claims 1-23 were pending in the present application, and claims 5, 14 and 20 have been canceled herein. Accordingly, claims 1-4, 6-13, 15-19 and 21-23 are currently pending.

The Examiner rejected claims 1-23 under 35 U.S.C. § 103(a) as being unpatentable over Chooi et al. (U.S. Patent No. 6,284,657) in view of applicants admitted prior art (AAPA) and Yi et al. (U.S. Patent No. 5,900,163). Applicant respectfully traverses this rejection. Applicant notes that the Examiner does not use Yi et al. in rejecting independent claims 1, 10 and 16.

Independent claim 1 specifically recites "performing a radio frequency (RF) sputter clean of the hole; and performing an anisotropic, ion enhanced organic etch of the hole at least partially during the sputter clean." To establish a prima facie case of obviousness, three basic criteria must be met. *See* M.P.E.P. § 2143. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art references when combined must teach or suggest all the claim limitations. Without conceding the second criterion, Applicant respectfully asserts that the references lack proper motivation to modify/combine in addition to lacking all the claim limitations.

With respect to the third criterion, none of the cited prior art, taken alone or in combination, teaches or suggests performing an anisotropic, ion enhanced organic etch at least partially during an RF sputter clean. AAPA states that, after a hole is etched in an organic interlayer dielectric (ILD), it is known to perform an RF sputter clean of the hole (p. 2, ll. 20). AAPA, however, clearly does not teach or suggest performing an anisotropic, ion enhanced organic etch at least partially during the RF sputter clean process.

Likewise, Chooi et al. do not teach or suggest performing an anisotropic, ion enhanced organic etch at least partially during an RF sputter clean process. The Examiner admits that Chooi et al. do not expressly teach that the argon acts as a sputter clean function. The Examiner also effectively admits that Chooi et al. do not expressly teach the anisotropic, ion enhanced organic etch component because the Examiner only states that Chooi et al. "inherently teach" that nitrogen in the plasma functions as ion enhanced organic etch. In fact, Chooi et al. never even

address performing a cleaning process step on the trench or via, let alone disclose a sputter clean in combination with an anisotropic, ion enhanced organic etch.

Specifically, a first section of Chooi et al., col. 6, ll. 37-43, cited by the Examiner with respect to plasma processing, describes the etch process shown in Fig. 6. This etch is performed on non-metallic layer 15, which "can be formed of a material such as silicon carbide, boron nitride, carbon nitride boron carbon nitride or boron carbide" (col. 6, ll. 29-32). Firstly, this section discloses an etch process, not a cleaning process, for etching layer 15, so there is no teaching or suggestion of a sputter clean process by Chooi et al., let alone an RF sputter clean. Secondly, there is not an exposed organic layer or displaced organic material on layer 15, so Chooi et al. cannot possibly teach or suggest an anisotropic ion enhanced organic etch. In other words, the etch of Chooi et al. cited by the Examiner cannot perform an organic etch if there is no organic material to etch.

A second section of Chooi et al., col. 9, ll. 48-49, cited by the Examiner with respect to plasma processing, describes the treatment process shown in Fig. 16. There is also a similar process performed subsequently in Fig 20. This plasma treatment process forms a "pseudo-carbon nitride" layer on the exposed surface of the dielectric layer (col. 9, ll. 52-61). Firstly, this process is actually forming a layer, which is effectively the opposite of etching a layer, and is completely unrelated to the sputter clean and organic etch of the claimed invention. Secondly, the Examiner is apparently combining unrelated processes from two separate embodiments disclosed by Chooi et al. in rejecting claim 1. The first plasma process is used in the first embodiment of Chooi et al. to etch a non-metallic layer, while the second plasma process is used in the third embodiment of Chooi et al. to form a pseudo-carbon nitride layer. Because these processes perform effectively opposite functions, the Examiner cannot properly combine the elements of these processes.

With respect to the first criterion of prima facie obviousness, motivation to modify/combine, the Examiner admits that Chooi et al. do not expressly teach that the argon acts as a sputter clean function. The Examiner then attempts to cure this deficiency by introducing AAPA, and alleging that AAPA discloses that knowledge generally available to one of ordinary skill in the art provides the requisite motivation. In particular, the Examiner states, "One of the ordinary skill in the art, however, would have recognized that the role of argon in the plasma

functions as the sputter clean because argon has been widely used as etching gas in physical sputter cleaning practice, as evidenced by AAPA."

It is well settled, however, that the prior art must suggest the desirability of the claimed invention, *see* M.P.E.P. § 2143.01, and the Examiner's stated motivation does not provide such a suggestion. A full reading of AAPA shows that the cleaning process is performed after a hole is etched, but before a liner or plug is formed (p. 2, ll. 11-16). The cleaning process may remove an oxide formed on the lower layer, as well as other residue left from the etch chemistry used to form the hole (*Id.*). Thus, while AAPA acknowledges that it is known to etch a hole, then clean the hole, then form a liner or plug in the hole, there is no teaching or suggestion in the cited references that an etching process for forming a hole or etching a layer in the hole can be used to clean the hole as well. Chooi et al. only disclose etching of the trench or via, or of a layer in the trench or via, and then immediately forming an additional layer in the trench or via. Chooi et al. completely ignore any cleaning step that may be performed between the etching a trench, via or layer, and the formation of a subsequent layer in the trench or via. Accordingly, there is no motivation to modify the etch processes disclosed by Chooi et al. to perform the RF sputter clean/organic etch process required by the claimed invention.

Independent claim 10 specifically recites "sputter cleaning the bottom of the hole with the physical etch component [of a plasma,] and anisotropically removing organic material from the bottom of the hole with the chemical etch component" of the plasma. Without conceding the second criterion of prima facie obviousness, Applicant respectfully asserts that the references lack proper motivation to modify/combine in addition to lacking all the claim limitations.

With respect to the third criterion, none of the cited prior art, taken alone or in combination, teaches or suggests sputter cleaning the bottom of a hole with the physical etch component of a plasma, and anisotropically removing organic material from the bottom of the hole with the chemical etch component of the plasma. AAPA states that, after a hole is etched in an organic interlayer dielectric (ILD), it is known to perform an RF sputter clean of the hole (p. 2, ll. 20). AAPA, however, clearly does not teach or suggest performing an anisotropic, ion enhanced organic etch at least partially during the RF sputter clean process.

Likewise, Chooi et al. do not teach or suggest sputter cleaning the bottom of a hole with the physical etch component of a plasma, and anisotropically removing organic material from the bottom of the hole with the chemical etch component of the plasma. The Examiner admits that Chooi et al. do not expressly teach that the argon acts as a sputter clean function. The Examiner also effectively admits that Chooi et al. do not expressly teach anisotropically removing organic material from the bottom of the hole because the Examiner only states that Chooi et al. "inherently teach" that nitrogen in the plasma functions as ion enhanced organic etch. In fact, Chooi et al. never even address performing a cleaning process step on the trench or via, let alone disclose sputter cleaning the bottom of a hole with the physical etch component of a plasma, and anisotropically removing organic material from the bottom of the hole with the chemical etch component of the plasma.

Specifically, a first section of Chooi et al., col. 6, ll. 37-43, cited by the Examiner with respect to plasma processing, describes the etch process shown in Fig. 6. This etch is performed on non-metallic layer 15, which "can be formed of a material such as silicon carbide, boron nitride, carbon nitride boron carbon nitride or boron carbide" (col. 6, ll. 29-32). Firstly, this section discloses an etch process, not a cleaning process, for etching layer 15, so there is no teaching or suggestion of a sputter clean process by Chooi et al. Secondly, there is not an exposed organic layer or displaced organic material on layer 15, so Chooi et al. cannot possibly teach or suggest anisotropically removing organic material from the bottom of the hole. In other words, the etch of Chooi et al. cited by the Examiner cannot perform an organic etch if there is no organic material to etch.

A second section of Chooi et al., col. 9, ll. 48-49, cited by the Examiner with respect to plasma processing, describes the treatment process shown in Fig. 16. There is also a similar process performed subsequently in Fig 20. This plasma treatment process forms a "pseudo-carbon nitride" layer on the exposed surface of the dielectric layer (col. 9, ll. 52-61). Firstly, this process is actually forming a layer, which is effectively the opposite of etching a layer, and is completely unrelated to the sputter clean and organic etch of the claimed invention. Secondly, the Examiner is apparently combining unrelated processes from two separate embodiments disclosed by Chooi et al. in rejecting claim 1. The first plasma process is used in the first embodiment of Chooi et al. to etch a non-metallic layer, while the second plasma process is used

in the third embodiment of Chooi et al. to form a pseudo-carbon nitride layer. Because these processes perform effectively opposite functions, the Examiner cannot properly combine the elements of these processes.

With respect to the first criterion of prima facie obviousness, motivation to modify/combine, the Examiner admits that Chooi et al. do not expressly teach that the argon acts as a sputter clean function. The Examiner then attempts to cure this deficiency by introducing AAPA, and alleging that AAPA discloses that knowledge generally available to one of ordinary skill in the art provides the requisite motivation. In particular, the Examiner states, "One of the ordinary skill in the art, however, would have recognized that the role of argon in the plasma functions as the sputter clean because argon has been widely used as etching gas in physical sputter cleaning practice, as evidenced by AAPA."

It is well settled, however, that the prior art must suggest the desirability of the claimed invention, *see* M.P.E.P. § 2143.01, and the Examiner's stated motivation does not provide such a suggestion. A full reading of AAPA shows that the cleaning process is performed after a hole is etched, but before a liner or plug is formed (p. 2, ll. 11-16). The cleaning process may remove an oxide formed on the lower layer, as well as other residue left from the etch chemistry used to form the hole (*Id.*). Thus, while AAPA acknowledges that it is known to etch a hole, then clean the hole, then form a liner or plug in the hole, there is no teaching or suggestion in the cited references that an etching process for forming a hole or etching a layer in the hole can be used to clean the hole as well. Chooi et al. only disclose etching of the trench or via, or of a layer in the trench or via, and then immediately forming an additional layer in the trench or via. Chooi et al. completely ignore any cleaning step that may be performed between the etching a trench, via or layer, and the formation of a subsequent layer in the trench or via. Accordingly, there is no motivation to modify the etch processes disclosed by Chooi et al. to perform the sputter clean/organic etch process required by the claimed invention.

Independent claim 16 specifically recites "performing an RF sputter clean of a bottom of the hole; performing an anisotropic, ion enhanced chemical organic etch of the hole, wherein the etch is performed at least partially during the RF sputter clean." Without conceding the second

criterion of prima facie obviousness, Applicant respectfully asserts that the references lack proper motivation to modify/combine in addition to lacking all the claim limitations.

With respect to the third criterion, none of the cited prior art, taken alone or in combination, teaches or suggests performing an anisotropic, ion enhanced chemical organic etch at least partially during an RF sputter clean of the bottom of a hole. AAPA states that, after a hole is etched in an organic interlayer dielectric (ILD), it is known to perform an RF sputter clean of the hole (p. 2, ll. 20). AAPA, however, clearly does not teach or suggest performing an anisotropic, ion enhanced chemical organic etch at least partially during the RF sputter clean of the bottom of the hole.

Likewise, Chooi et al. do not teach or suggest performing an anisotropic, ion enhanced chemical organic etch at least partially during an RF sputter clean of the bottom of a hole. The Examiner admits that Chooi et al. do not expressly teach that the argon acts as a sputter clean function. The Examiner also effectively admits that Chooi et al. do not expressly teach the anisotropic, ion enhanced chemical organic etch component because the Examiner only states that Chooi et al. "inherently teach" that nitrogen in the plasma functions as ion enhanced organic etch. In fact, Chooi et al. never even address performing a cleaning process step on the trench or via, let alone disclose a sputter clean in combination with an anisotropic, ion enhanced chemical organic etch.

Specifically, a first section of Chooi et al., col. 6, ll. 37-43, cited by the Examiner with respect to plasma processing, describes the etch process shown in Fig. 6. This etch is performed on non-metallic layer 15, which "can be formed of a material such as silicon carbide, boron nitride, carbon nitride boron carbon nitride or boron carbide" (col. 6, ll. 29-32). Firstly, this section discloses an etch process, not a cleaning process, for etching layer 15, so there is no teaching or suggestion of a sputter clean process by Chooi et al., let alone an RF sputter clean. Secondly, there is not an exposed organic layer or displaced organic material on layer 15, so Chooi et al. cannot possibly teach or suggest an anisotropic ion enhanced chemical organic etch. In other words, the etch of Chooi et al. cited by the Examiner cannot perform an organic etch if there is no organic material to etch.

A second section of Chooi et al., col. 9, ll. 48-49, cited by the Examiner with respect to plasma processing, describes the treatment process shown in Fig. 16. There is also a similar

process performed subsequently in Fig 20. This plasma treatment process forms a "pseudo-carbon nitride" layer on the exposed surface of the dielectric layer (col. 9, ll. 52-61). Firstly, this process is actually forming a layer, which is effectively the opposite of etching a layer, and is completely unrelated to the sputter clean and organic etch of the claimed invention. Secondly, the Examiner is apparently combining unrelated processes from two separate embodiments disclosed by Chooi et al. in rejecting claim 1. The first plasma process is used in the first embodiment of Chooi et al. to etch a non-metallic layer, while the second plasma process is used in the third embodiment of Chooi et al. to form a pseudo-carbon nitride layer. Because these processes perform effectively opposite functions, the Examiner cannot properly combine the elements of these processes.

With respect to the first criterion of prima facie obviousness, motivation to modify/combine, the Examiner admits that Chooi et al. do not expressly teach that the argon acts as a sputter clean function. The Examiner then attempts to cure this deficiency by introducing AAPA, and alleging that AAPA discloses that knowledge generally available to one of ordinary skill in the art provides the requisite motivation. In particular, the Examiner states: "One of ordinary skill in the art, however, would have recognized that the role of argon in the plasma functions as the sputter clean because argon has been widely used as etching gas in physical sputter cleaning practice, as evidenced by AAPA."

It is well settled, however, that the prior art must suggest the desirability of the claimed invention, *see* M.P.E.P. § 2143.01, and the Examiner's stated motivation does not provide such a suggestion. A full reading of AAPA shows that the cleaning process is performed after a hole is etched, but before a liner or plug is formed (p. 2, ll. 11-16). The cleaning process may remove an oxide formed on the lower layer, as well as other residue left from the etch chemistry used to form the hole (*Id.*). Thus, while AAPA acknowledges that it is known to etch a hole, then clean the hole, then form a liner or plug in the hole, there is no teaching or suggestion in the cited references that an etching process for forming a hole or etching a layer in the hole can be used to clean the hole as well. Chooi et al. only disclose etching of the trench or via, or of a layer in the trench or via, and then immediately forming an additional layer in the trench or via. Chooi et al. completely ignore any cleaning step that may be performed between the etching a trench, via or layer, and the formation of a subsequent layer in the trench or via. Accordingly, there is no

motivation to modify the etch processes disclosed by Chooi et al. to perform the RF sputter clean/organic etch process required by the claimed invention.

Accordingly, Applicant respectfully asserts that independent claims 1, 10 and 16 are patentable over Chooi et al. in view of AAPA and Yi et al. Claims 2-4 and 6-9 depend from claim 1, claims 11-13 and 15 depend from claim 10, and claims 17-19 and 21-23 depend from claim 16. Without conceding that the Examiner's assertions are valid with respect to the limitations of the rejected dependent claims, Applicant respectfully submits that claims 2-4, 6-9, 11-13, 15, 17-19 and 21-23 are patentable over Chooi et al. in view of AAPA and Yi et al. because of their dependency from their respective independent claims for the reasons discussed above.

In view of the above, this application is considered to be in condition for allowance and such action is earnestly solicited. Applicant respectfully requests that the Examiner call the below listed attorney if the Examiner believes that such a discussion would be helpful in resolving any remaining issues.

Respectfully submitted,

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